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## Review

# The 2019 global pandemic and plastic pollution prevention measures: Playing catch- up

João Pinto da Costa

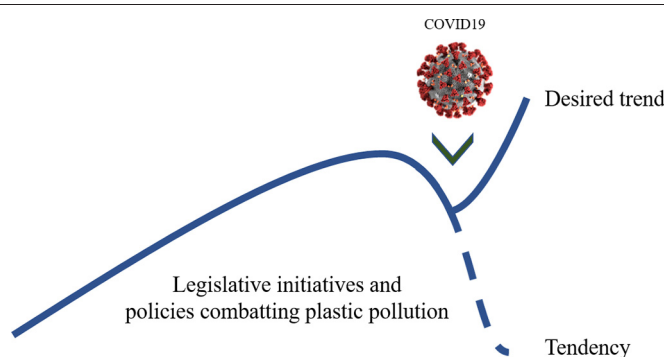
Department of Chemistry & Center for Environmental and Marine Studies (CESAM), University of Aveiro, 3810-193 Aveiro, Portugal



## HIGHLIGHTS

- Globally, a high number of initiatives fighting plastic pollution were in place.
- The COVID19 pandemic has resulted in halting many of these initiatives.
- The halted, paused, cancelled or delayed regulatory instruments are overviewed.
- The need to implement the already devised and new, stricter regulations, is stressed.

## GRAPHICAL ABSTRACT



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## ABSTRACT

The early 2000's encompassed a rising awareness by the scientific community, the general public and policy makers of the impending environmental catastrophe caused by the increasing prevalence of plastics in the environment. Soon thereafter, a slew of regulatory initiatives and policies and actions targeting plastic pollution were put forth by governments, international institutions, non-governmental organizations, companies and even by citizen groups. However, the 2020 COVID19 pandemic has disrupted this momentum, and, presently, many fear that plastic pollution will increase, not only due to the increased consumption of single-use plastic items, but also due to the ever growing need of personal protective equipment. Many plastic pollution reduction policies have been suspended, cancelled or postponed. Herein, some of these delayed policies and initiatives are overviewed and, based on publicly available data, the questions as to whether, at a global level, increased government action to address plastic pollution will continue, or will the pandemic change this paradigm, are tentatively answered, as well as whether the pandemic will affect plastic production, in particular, single-use plastics, and what the potential routes to overcome these tendencies may be. As such, the dynamics of the interaction between the restrictive measures adopted in the wake of this pandemic and plastic pollution are examined, as are the roles of different legislative and regulatory bodies, whether at the local, regional or international levels.

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E-mail address: [jpintocosta@ua.pt](mailto:jpintocosta@ua.pt).

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## 1. Introduction

The coronavirus disease of 2019 (COVID-19), that became a Global pandemic by 2020, has changed many aspects of daily life and has indelibly altered our way of life. Presently, the future appears to be less urban and less global (Garrett, 2021). The repercussions of this health crisis are expected to extend across all aspects of daily life, ranging from micro- and macroeconomics (Atkeson, 2020; McKibbin and Fernando, 2020), information management and research (Dwivedi et al., 2020), education (Azevedo et al., 2020), to governance (Janssen and van der Voort, 2020) mental health (Serafini et al., 2020) and even territorial integrity and cohesion (OECD, 2020). The environment is no different.

The combat against the pandemic has resulted in, and continues to yield, vast amounts of waste, particularly medical waste, but also household waste, the composition of which is greatly affected by disposable plastic-based personal protective equipment (PPE) and single-use packaging plastics, stemming from the noted surge in online shopping (da Costa et al., 2020). Unfortunately, comprehensive and detailed data on this increase is presently unavailable, but initial reports point to significant changes in waste generation and treatment dynamics (Singh et al., 2020), with concomitant uncertainties and difficulties not only for sanitation workers, whom are particularly exposed (Salve and Jungari, 2020), but also to policymakers. Gloves, masks and other polymeric-based PPE, whether infected or not, can potentially contaminate the general municipal solid waste, including in the form of microplastics, particularly microfibers released from disposable facemasks (Fadare and Okoffo, 2020).

Although exact values are not known, China alone increased its facemask production from January to February to 110 million units, representing an increase of 450% (Bown, 2020). The WWF estimated that, for Italy alone, the deconfinement phase would require 1 billion face masks and 0.5 billion gloves (WWF, 2020). A conservative extrapolation of these values for the entire European population yields an estimated need 7.4 and 3.7 billion units of masks and gloves needed on a monthly basis (da Costa et al., 2020). Other approximations point to nearly 130 billion face masks and 65 billion gloves now used globally every month (Vasil, 2021). These values contribute to an estimated increase of 250 to 300% in single-use plastic consumption than during the pre-pandemic period (Knowles, 2020). All this happened just when the movement against single-use plastic was picking up steam, owing to the growing awareness of the issue of plastic pollution. Thoroughly reviewed elsewhere (e.g., Borrelle et al., 2020; Critchell et al., 2019; Sigler, 2014), it is evident that the increasing levels of environmental plastic contamination negatively impact wildlife, ecosystems, economy and, ultimately, human health. This is underscored by the prevalence of these materials at a Global level, throughout remote locations (Andrades et al., 2018; Cincinelli et al., 2017) and including protected areas, such as sanctuaries (Guerrini et al., 2019). Hence, developing and implementing relevant legislation, regulations and policies, as well as local, regional and global initiatives is vital to combat plastic pollution and successfully address this environmental issue.

## 2. Plastic use and the pandemic

From the early municipal regulations, in the 2000's, to the United Nations "war on plastics", the issue of plastic pollution, particularly in the ocean, had gained momentum owing to its rise in governments' agendas (Karasik et al., 2020), propelled by the increasing public awareness and engagement. The pandemic, however, has disrupted this

momentum. This has led to concerns that plastic pollution will increase not only due the described increased consumption of single-use plastic items and disposable PPE, but also due to the suspension of plastic pollution reduction policies and the increasing production outputs of plastics. In fact, plastic production continues to increase and the latest available numbers show that, globally, 368 million tons of plastics were produced in 2019 (EPC, 2020). This observed pause in addressing the issues of plastic pollution has been compounded by the pushback by plastic manufacturers and allied interests on numerous initiatives restricting single-use plastics by, for example, urging consumers to "say no to bans and taxes on your grocery bags" (ARPBA, 2019). These same groups have capitalized on this global health crisis, specifically, by continuously emphasizing the need to resort to single-use plastics to combat this pandemic, as evidenced in a letter by the Plastics Industry Association (PIA) addressed to the U.S. Department of Health and Human Services (HHS). In this document (available at <http://shorturl.at/sEKV9>), PIA mentions that three studies "have shown that reusable bags can carry viruses and bacteria, spread them throughout a grocery store, and live on surfaces for up to three days" and therefore requested that HHS should "speak out against bans on these products" as these could put "consumers and workers at risk" of contracting COVID-19. This marked the pinnacle of a concerted effort that marked a pivotal change in the implementation of plastic-combating policies and initiatives. However, the studies cited by PIA do not support the premise that incidental contact with reusable bags in grocery stores, for example, could lead to transmission of the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). Briefly, one focused on food-borne bacteria and coliforms, not coronaviruses, on the inside (not exterior surface) of reusable plastic bags (Barbosa et al., 2019); another (Williams et al., 2011), also referred to the interior of reusable bags, to bacteria and the authors themselves stressed that "washing was found to reduce the bacteria in bags by >99.9%". Additionally, these authors also noted that such contamination could stem from occasionally soiled clothing kept in said reusable bags (Williams et al., 2011). The last study, from 2012, referred to a norovirus outbreak in the US potentially caused by the consumption of food kept in a contaminated reusable bag (Repp and Keene, 2012). Not only did the authors note that the index case did not touch the reusable bag nor the food contents, they were also unable to ascertain which factor - handling of the reusable bag or the consumption of food contained in it - was the vector of transmission, as subsequently emphasized by other researchers (Hale and Song, 2020). Most importantly, though, none of the studies cited by PIA to support their claim focused on the prevalence, survival or infectivity rates of any coronavirus family members, let alone of SARS-CoV-2. In fact, in environments such as grocery stores, research (Geller et al., 2012; Van Doremalen et al., 2020) allows to postulate (Hale and Song, 2020) that human interactions, as skin contact and respiratory aerosols, as well as contact with surfaces recently contaminated, are likely more prevailing vectors of SARS-CoV-2 transmission than occasionally used reusable bags. Yet, plastic surfaces appear to allow coronaviruses to remain infectious for particularly longer periods of time when compared to other materials (Van Doremalen et al., 2020), but no scientific evidence exists detailing higher rates of transmission or infectivity between reusable plastic materials and single-use plastics. In other words, the currently available research does not support the use of single-use plastics over reusable ones. In fact, over 125 public health officials from all over the World have issued a statement emphasizing that reusable materials, namely, bags, are safe during the pandemic if basic hygiene principles are observed (ExpertStatement, 2020). Although research suggests

that the virus may survive in materials as varied as polystyrene plastic, aluminum, and glass for at least 96 h (Pastorino et al., 2020), the viral load greatly decreases with time, thus reducing infectivity, and, if common-sense practices are used, as washing or disinfecting bags, storing bags in isolated sections in the household, wearing of masks and frequent hand-washing, prior, during and following reusable materials, as well as bagging one's own groceries, there is little risk of transmission. Additionally, single-use plastics can also incur in heightened COVID-19 transmission risks, as shopping bags, for example, may constitute a vector between employees and consumers, and, if improperly disposed of, may become virus-contaminated litter. Extending these relatively simple sanitary measures to related production/consumption sectors constitutes a valuable opportunity for creating safety protocols in the daily routine. Also, communities living near plastic manufacturing facilities and industrial areas exhibit higher rates of respiratory illnesses, and these have been shown to have disproportionately higher rates of COVID-19 infection (Wu et al., 2020).

In spite of all these data and facts, the well-concerted publicity effort put in motion by the plastics industry paid off. The limited publicly available data shows that some companies benefitted greatly from this marketing strategy: Ineos Styrolution Group GmbH (Germany) and U.S.-based Trinseo SA reported a double-digit percentage increase in sales in their healthcare and food packaging divisions (Kaufman, 2020), while Spanish packaging company Ingamark Spain reported a staggering 40 per cent increase in sales (Salvá, 2020). At the regulatory level, there were also consequences of this publicity effort, namely, in the form of a growing number of suspensions or holdups in the implementation of restrictions or bans on single-use plastics not only at the local, state/regional and national government levels, but also by businesses and companies.

Scotland, for example, has delayed the implementation date for a deposit return scheme from April 2021 to July 2022, arguing that businesses could not have sufficient time to ensure the existence of the needed infrastructures (BBC, 2020). In England, the much-announced ban on plastic straws and cotton buds has been postponed for a minimum period of 6 months (O'Connor, 2020). In the US, multiple municipalities and states have either postponed or rescinded numerous initiatives aimed at reducing plastic pollution, including the lifting of previously scheduled bans. For example, in Hawaii, the Plastic Ban Reduction predicts that "local stores will continue to use paper bags as a

priority while their supplies last; plastic bags may be used for greater volume or wetter items" (DEM, 2020). In New Hampshire, a statewide plastic ban bill (HB559) was withdrawn, with plans to revisit the decision in subsequent sessions (NHGC, 2020). A working tracker by the Product Stewardship Institutes, available at <http://shorturl.at/cDWY>, currently lists dozens of municipal or state wide legislative initiatives that have been delayed, suspended or completely withdrawn, a worrying scenario in the nation deemed to be the largest producer of plastic waste (Law et al., 2020). These concerns are exacerbated by the fact that, due to the dramatic decline in transportation, the price of petroleum has severely decreased, thus favoring the manufacture and use of virgin plastics, as opposed to recycled materials. Table 1 lists some of the global impacts of COVID-19 on regulatory initiatives aimed at curtailing or banning single-use plastics.

Conversely, other countries, such as France, are considering increased fines for littering owing to the increase observed in improper disposal of PPE (Tidman, 2020), while, at the European level, the EU has dismissed the plastic industry's calls to lift the ban on single-use plastics (da Costa et al., 2020). In July, a levy on plastic waste to help fund national pandemic recovery efforts was proposed (Simon, 2020). The resolution must be ratified by the parliaments of all member-states and the EU expects to complete this ratification process by the end of December 2020, paving the way for the new system – expected to yield between €6–€8 billion of additional revenue each year – may begin operating starting January 2021.

Although the obvious need for disposable PPE, as well as the devastating economic impacts of the COVID-19 pandemic may explain some of the eased implementation periods and guidelines, these regulatory instruments should be considered in the framework and context for and with which they were designed. For example, the delayed implementation date of the deposit return scheme in Scotland should not be considered well founded and, in fact, has been fiercely criticized by key stakeholders, namely, owing to the fact that the announced targets would be postponed until at least 2023 (BBC, 2020).

### 3. Moving forward

Fighting the pandemic has taken precedence over nearly all other policies and initiatives, including combatting plastic pollution. Measures

**Table 1**

Examples of the impacts of COVID-19 on plastics policies. Some of these remain delayed, have been withdrawn and a fraction of these have been reinstated. The list is merely exemplificative and does not purport to be exhaustive.

Region	Country/state/municipality	Policy	Status	Ref.
Canada	Nationwide	Single-use plastic ban	Likely delayed (planned for Jan 2021)	(Rabson, 2020)
USA	California (statewide)	Bag fees	Reinstated	(GoC, 2020)
	California – Santa Cruz	Single-use bag fee	Delayed	(DOC-2020-650, 2020)
	Colorado – Denver	Plastic bag fee	Delayed	(Sachs, 2020)
	Hawaii (statewide)	Plastic Bag Reduction Ordinance	Delayed	(DEM, 2020)
	Maine (statewide)	Single-use plastic ban	Delayed	(Bomey, 2020)
	Massachusetts (139 municipalities)	Single-use plastic ban	Delayed	
	New Hampshire (statewide)	Plastic ban	Reinstated	(NHGC, 2020)
	New York (statewide)	Bag Waste Reduction Law	Reinstated	(DEC, 2020)
	Oregon (statewide)	Plastic bag ban	Delayed	(Bomey, 2020)
	Pennsylvania – Philadelphia	Plastic bag ban	Delayed	(CoF, 2020)
	Washington – Kitsap county	Plastic bag ban	Delayed	(Kitsap, 2020)
Europe	EU	Single-use plastic ban	Upheld	(da Costa et al., 2020)
	England	Plastic straws and cotton buds ban	Delayed	(O'Connor, 2020)
	Italy	Tax on virgin plastics	Delayed	(Tudball, 2020)
	Portugal	Single-use plastic ban	Delayed	(SaR, 2020)
	Scotland	Deposit return scheme	Delayed	(BBC, 2020)
	The Netherlands	Deposit return scheme	Remains planned for July 2021	(PlastEurope, 2020)
Africa <sup>a</sup>	Senegal	Single-use plastic ban	Upheld, not enforced	(PhysOrg, 2020)
Asia	Australia (South Australia)	Single-use plastic ban	Delayed	(Dayman, 2020)
	India	Single-use plastic ban	Delayed	(Fox, 2020)
	Thailand	Single-use plastic ban	Upheld, not enforced	(DWNews, 2020)

<sup>a</sup> Out of the 54 African nations, 34 presently have legislation banning plastics or have passed such laws with the intention of implementation. Though these vary greatly in scope, extent and enforcement, no evidence that such bans, except in Senegal, have been postponed, delayed or not enforced exist (Greenpeace, 2020).



put in place, namely, in the form of halted policies or postponed regulatory instruments, stem from a renewed hierarchization of priorities. Environmentally, however, this hierarchal shift paradigm may result in significant impacts that may further compromise the integrity of ecosystems. They may jeopardize any remaining chance of firmly addressing the issue of plastic pollution, which remains one of the greatest challenges of our age, including in protected areas, such as sanctuaries, in which anthropogenic activities, such as boating, tourism and fishing, have been demonstrated to constitute substantial sources of plastic pollution (Bauer et al., 2008; Guerrini et al., 2019). Measure for reducing plastic waste and fighting plastic pollution should, therefore, remain steadfast. In the context of this global pandemic, such measures include, for example, the adequate characterization of municipal waste, particularly given the continuously changing dynamics on composition and disposal. Additionally, this knowledge will allow to better ascertain the type and fraction of waste that may be susceptible to be reused (followed by adequate decontamination protocols), and which should be incinerated or landfilled. This will also allow for improved and more sustainable waste management protocols – from larger capacities of mobile facilities (when needed), to automation and transition to non-incineration disposal technologies, as dry heat, autoclave steam, chemical disinfection or microwave – to provide a safer environment and contribute to reducing the transmission of the COVID-19 virus among sanitation workers, in particular, and the population, more broadly. These, naturally, should be selected based upon not only the inherent associated implementation and maintenance costs, but also on the type of waste, material and subsequent fate. For PPE, including surgical masks and N95 respirators, as well as face shields, UV radiation (UV-C), ozonation, and heat and microwave-based procedures appear to be valid decontamination protocols (Cadnum et al., 2020; Dennis et al., 2020; Gertsman et al., 2020), as well as the use of ethylene oxide, vaporized hydrogen peroxide or bleach (Su-Velez et al., 2020; Viscusi et al., 2009). However, as noted by different authors (Narla et al., 2020; Ozog et al., 2020), such decontamination methods should be carefully evaluated and post-disinfection, as the myriad of currently types of protective equipment and the different materials used could react differently to such protocols, as evidenced in the case of UV-C, shown to degrade polymers in the masks/respirators and to have a negative impact on the elasticity of the bands (Lindsley et al., 2015). It is not surprising, therefore, that alternatives for addressing PPE waste have been suggested, as conversion of this waste into biofuel (Jain et al., 2020), though the industrial feasibility of such processes remains undetermined.

Yet, most importantly, it emerges that the planned regulatory initiatives aiming at curtailing plastic pollution should not be paused, postponed or cancelled. There is, in fact, the need to reinforce such measures. For example, these should also focus more intensely on the source of these materials, in particular when they are not intended for the production of necessary materials and equipment to combat COVID-19, as has been the case owing to the aforementioned reduction in oil prices. International fora, such as the World Trade Organization, could play an important role in increasing transparency and strengthening international cooperation, by lending its support for innovative production and reuses of goods and products, promoting strict international standards and sustainability in trade. In spite of the pandemic, significant headway has been achieved in recent weeks, with an international agreement, likened to the Paris Agreement (Agreement, 2015) and thus dubbed the “Paris Agreement on plastics”, gaining increasing momentum. This new global agreement focuses on marine litter and microplastics and advocates state that the current existing international legal framework governing plastic pollution is fragmented and ineffective (McVeigh, 2020). This potential treaty includes a range of new provisions, including: global and national reduction targets, global design standards, phasing out avoidable plastic products and mandates for national action plans (MacFarlane et al., 2020). Much remains unknown, however, including whether reduction targets will only apply to discharged litter or also to production and consumption

of plastic, or if global design standards will apply only to plastic packaging or to other plastic products, as well as the legally binding nature of this accord. Nonetheless, the evidenced convergence and growing consensus in support of such regulatory initiatives, particularly in the present context of this pandemic, is a welcomed development. Surprisingly, numerous global brand name companies have voiced their support for such a treaty, by calling on the UN to develop a treaty on plastic pollution harmonizing regulatory standards, defining common metrics and mandating national actions plans focused on eliminating discharge of plastic into the environment. Their manifesto also asks for support for the development of new technologies and infrastructure to help drive the transition to a plastic circular economy (WWF et al., 2020). All these issues are certainly to be addressed in the upcoming fifth session of the UN Environment Assembly, expected to take place during the last week of February 2021, in Nairobi, Kenya.

#### 4. Final considerations

Environmentally, the onset of the COVID-19 pandemic ushered in improvements in air quality, beach cleanliness and reduced environmental noise; conversely, it was also accompanied by a significant reduction in recycling and increase in waste, in particular, plastic waste. The initial shortage of PPE and the need to ensure a safe environment for those in the frontline of this pandemic led to a marked increase in the levels of plastic production, exacerbated by a reduction on the price of oil, stimulating the manufacture of virgin plastics. This resulted in many countries and companies to put on hold long awaited policies and initiatives fighting plastic pollution, halting a process that, unless quickly resumed and reinforced, will have disastrous environmental consequences. Presently, an estimated 11 million metric tons of plastic waste end up into the ocean each year, a volume that is expected to triple over the next 20 years. Comprehensive and decisive actions are needed, as the increasing number of voluntary initiatives and national regulations remain insufficient. Many of the existing policies – some of which are paused or whose implementation has been delayed – do not target the right issues, or are rather limited in scope. For example, two-thirds of countries that presently have some form of regulations on plastic items only focus on single-use plastic bags; yet, in beach cleanup initiatives, these items account for just 7% of all plastic items found. Moreover, among the top 20 countries responsible of mismanaged plastic waste, only 1/3 has the needed infrastructures to adequately manage plastic waste. In this context, perhaps more effective than local, national or even regional regulatory initiatives, a global treaty, whereby governments and non-governmental organizations commit to and enforce a coordinated set of actions and policies, may actively contribute to significantly reduce plastic pollution while concomitantly paving the way towards a circular economy for plastics. However, whichever path is determined, halting, delaying or pausing policies addressing plastic pollution, are no longer options.

#### Declaration of competing interest

The author declares no conflict of interest.

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